Project Title: Forage Species Studies in Prince William Sound

Project Number:	00163A
Restoration Category:	Research
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ABL Program Manager:	Dr. Stan Rice
NOAA Program Manager:	Bruce Wright
Lead Trustee Agency:	NOAA
Cooperating Agencies:	ADF&G, USFW, UAF
Duration:	1 year
Cost FY00:	$138 K
Cost FY01:	
Cost FY02:	
Geographic Area:	Prince William Sound, Alaska
Injured Resource:	Forage fish, sea birds

ABSTRACT

Forage fish studies in Prince William Sound (PWS) is a project that estimates the biomass and distribution of forage fish in nearshore habitat of three geographic regions of PWS from 1996 - 1999. Biomass of forage fish is estimated hydroacoustically and species composition and size is verified by capture with purse seines, trawls, and underwater video cameras. Areas of forage fish aggregations are characterized by habitat type and oceanographic features in the three study regions. The overall objective of this phase of the project is to evaluate the inter-annual variability of forage fish distribution, abundance, and availability to apex predators, with habitat and oceanographic features.

INTRODUCTION

Prince William Sound (PWS) is one of the largest areas of protected waters bordering the Gulf of Alaska (GOA). It, and the nearby open waters of the Gulf, provide a foraging area for large populations of apex predators including piscivorous seabirds and marine mammals. These surface-dependent predators were severely impacted by the EXXON VALDEZ oil spill (EVOS); and many - especially common murres, marbled murrelets, pigeon guillemots and harbor seals - suffered population declines that have not recovered to pre-EVOS levels. Piscivorous seabirds and marine mammals in PWS are near the apex of food webs based on pelagic production of small fishes and macroinvertebrates. Recovery of apex predator populations in PWS depends on restoration of important habitats and the availability of a suitable forage base. Since the 1970's there apparently has been a decline in populations of apex predators in the pelagic plankton production system, and it is not clear if failure to recover from EVOS-related reductions is due to long-term changes in forage species abundance or to EVOS effects. In this proposal we describe data analysis and manuscripts that will provide quantitative descriptions of the forage community in PWS .

BACKGROUND

Forage species include planktivorous fishes and invertebrates. Planktivorous fish species that occur in PWS and are known or likely prey of apex predators include Pacific herring (*Clupea pallasi*), Pacific sand lance (*Ammodytes hexapterus)*, walleye pollock (*Theragra chalcogramma*), capelin (*Mallotus villosus*) and eulachon (*Thaleichthys pacificus*). Among these, Pacific herring are commercially valuable in PWS and have been studied extensively by Alaska Department of Fish and Game (ADF&G) to facilitate management. Data available for Pacific herring include population size, year-class abundance, and growth. Walleye pollock are commercially valuable in the western GOA and the Bering Sea; consequently there are considerable data describing populations and biology in those areas, but relatively little information on pollock in PWS. The other fish species are not commercially important in Alaska and have received little study, although some scattered information allows a preliminary assessment of their life-history features, distributions and food habits.

Pacific herring populations in PWS are monitored through egg surveys, with subsamples aged to estimate year-class abundances. Through the 1980's herring abundances were relatively high in PWS, with cyclical strong year classes. In 1993 and 1994 herring populations were reduced sharply, adults had relatively high incidences of lesions caused by viral hemorrhagic septicemia (VHS), and the mean size at age was abnormally low. Apparently herring populations in PWS have been seriously stressed in recent years. Although linkage to the EVOS is not clearly demonstrated, herring declines may be due to post-EVOS changes in the pelagic production system of PWS.

In the western GOA and Bering Sea, juvenile walleye pollock are planktivorous and are preyed

upon by apex predators. In Shelikof Strait in April walleye pollock comprised about 99% of midwater planktivores (Brodeur and Merati 1993). In PWS walleye pollock are probably important forage species. In a bottom trawl survey of PWS, walleye pollock were the most abundant species (Parks and Zenger 1979). In our acoustic survey of PWS in July and August of 1995, YOY pollock were by far the most abundant small pelagic fishes in PWS. Juvenile walleye pollock are very important constitutents of the diets of piscivorous seabirds (Springer and Byrd 1989, Divoky 1981) and marine mammals (Lowry et al. 1989, Pitcher 1980, 1981).

Pacific sand lance occur throughout the GOA, and are important forage species wherever they occur. They are planktivorous, feeding on euphausiids and copepods, with euphausiids more important in winter months (Craig 1987). Throughout their range, calanoid copepods have generally been reported as their principal prey (Simenstad and Manuwal 1979, Rogers et al 1979, Cross et al. 1978, Craig 1987). Pacific sand lance have been reported as prey for a variety of marine seabirds including common murres (Drury et al. 1981, Springer et al 1984), puffins (Wilson et al. 1984), auklets (Vermeer 1979, Wilson and Manuwal 1984), and murrelets (Sealy 1975). They are also eaten by many marine mammals including harbor seals (Pitcher 1980) and Steller sea lions (Pitcher 1981). There is little information on the abundance and distribution of sand lance in the PWS area, but they are probably an important intermediate link in the food webs that support apex predators.

Two smelt species, capelin and eulachon, are probably important forage species in PWS. In a bottom trawl survey conducted in April, eulachon were the fifth most abundant species collected overall, but was the dominant species in depths over 200 fm. (Parks and Zenger 1979). Those fish were ready to spawn and apparently were intercepted while migrating to their spawning grounds in rivers. Eulachon are important forage species throughout Alaska, and may be the most important forage fish in the southern Bering Sea (Warner and Shafford 1981). Capelin spawn on nearshore sandy substrates. In the northern Gulf of Alaska (Kodiak) they spawn in May and June (Warner and Shafford 1978, Pahlke 1985). They are prey of many piscivorous seabirds (Baird and Gould 1984) and marine mammals (Fiscus et al. 1964).

Macro zooplankton; including euphausiids, shrimp, mysids and amphipods; are a central component in the diets of herring, sand lance, capelin and pollock, as well as young salmon (Clausen 1983, Coyle and Paul 1992, Livingston et al. 1986, Straty 1972). When aggregated in sufficient densities, Macro zooplankton are fed on directly by marine birds (Coyle et al. 1992, Hunt et al 1981, Oji 1980). Swarming behavior by breeding euphausiids (Paul et al. 1990b) and physical factors (Coyle et al. 1992, Coyle and Cooney 1993) may concentrate Macro zooplankton and micronekton into aggregations of density suitable for efficient foraging by predators. Unfortunately, there is little information on the abundance, distribution and fluctuations of these key invertebrates in the EVOS impact region. In the GOA zooplankton abundance has varied on a decadal time scale (Brodeur and Ware 1992); and, superimposed on longer cycles, are inter-annual fluctuations as high as 300% (Frost 1983, Coyle et al. 1990, 1992, Paul et al. 1990a, 1990b, 1991, Paul and Coyle 1993). Such variability in abundance may affect populations of apex predators in PWS.

NEED FOR THE PROJECT

A. Statement of Problem

This project is the cornerstone of a larger ecosystem project (APEX) and will provide information leading to a better understanding of the link between prey and predator and of the population dynamics of forage species in PWS. Data from this project needs to be integrated with seabird and aerial forage fish survey data to help better understand the link between predator and prey. An inter-annual summary of forage fish distribution and abundance needs to be addressed in relation to availability to predators, habitat use, and oceanographic features.

B. Rational

An ecosystem approach to describing inter-annual variation in forage fish distribution, abundance, and species composition must integrate habitat and oceanographic considerations in relationship to prey availability. This research is needed to address the working hypotheses that forage fish species differ in their spacial responses to oceanographic processes; and forage fish characteristics limit availability of seabird prey. Therefore, in order to relate variation in forage fish availability to the decline of seabird populations in PWS, concurrently obtained forage fish, seabird, habitat, and oceanographic data needs to be synthesized.

PROJECT DESIGN

Objectives

1. Estimate the distribution and abundance of forage species in three near-shore study areas in Prince William Sound.

2. Describe the species composition of the forage base and size distributions of the most abundant forage fish species in the three study areas.

3. Describe basic oceanographic conditions in the study area including salinity, temperature, and sigma-t profiles of the water column and water depth at all sites of data collection at the three study areas.

4. Describe the habitat types of areas where forage fish are present.

5. Compare relative abundance of zooplankton in the three near-shore core areas in Prince William Sound.

6. Test APEX hypotheses related to forage fish abundance, distribution, and availability to apex predators.

Cooperating Agencies, Contracts and Other Agency Assistance

This project will coordinate with the other APEX projects so that forage fish biomass and oceanographic data can be integrated with seabird and nearshore vertebrate predator data.

Milestones and Endpoints

1. October - December 1999 - Analyze 1999 hydroacoustic data

2. October - December 1999 - Analyze 1999 zooplankton samples

3. October - December 1999 - Analyze 1999 forage fish length-weight data

4. October - December 1999 - Analyze 1999 forage fish abundance and distribution data

5. October - December 1999 - Analyze 1999 oceanographic data

6. October - December 1999 - Analyze 1999 habitat classification data

7. October - December 1999 - Synthesize 1996 - 1999 forage fish and oceanographic data

8. January - March 2000 - Integrate forage fish data with oceanographic data

9. January - March 2000 - Integrate forage fish data with habitat classification data

10. January - March 2000 - Integrate forage fish data with zooplankton data

11. January - March 2000 - Integrate forage fish data with APEX and SEA data

12. April - September 2000 - Prepare final report

13. April - September 2000 - Prepare two manuscripts (Lead authors)

14. April - September 2000 - Collaborate in preparation of three manuscripts

15. September 2000 - Post summarized results from our inter-annual comparisons of the forage fish assessment project on the APEX web site.

16. October - April 2000 - Prepare one manuscript

Publications and Reports

The Forage Fish Studies project is the cornerstone of the APEX project -- all other predators (birds, marine mammals) are related to the forage base. Most APEX projects rely on this project to provide them with forage fish specimens, estimates of biomass and species composition, and oceanographic data to integrate and calibrate with seabird data and to formulate models of food availability and seabird recovery.

In FY2000, two peer-reviewed manuscripts are planned:

Thedinga, Hulbert, Brown, Halderson. Distribution and abundance of forage fish and availability to predators related to oceanographic and physical conditions in PWS.

This manuscript will compare different species of forage fish and determine how their distribution and abundance determined hydroacoustically and by aerial surveys and availability to predators is related to oceanographic features and physical conditions in PWS such as such as frontal zones, thermoclines, pycnoclines, haloclines, convergences, or major currents.

Hulbert, Thedinga, Ostrand, Halderson, Brown. Distribution and abundance of forage fish related to habitat type.

This manuscript will compare different species and age classes of forage fish and determine how their distribution and abundance are related to habitat type. A habitat typing system used by NVP will be used to classify habitat in the sampling areas.

Thedinga, Brown, Ostrand, Hulbert, Norcross. Relationship between aerial estimates and acoustical estimates of forage fish biomass in PWS.

This manuscript will compare aerial estimates of forage fish abundance with acoustical estimates of forage fish biomass and determine relationships between species and size composition with the two estimates based on net and video samples of forage fish.

Ostrand, Irons, Maniscalco, Thedinga. Availability of forage fish to seabirds.

This manuscript will compare distribution of forage fish (depth, distance from beach, school size, species composition, size distribution) to foraging behavior of seabirds in three study areas of PWS.

Purcell, Hulbert, Brown Hulbert. Dietary overlap of jellyfish and forage fish.

This manuscript will compare the diet of jellyfish and forage fish and describe the role of jellyfish in the PWS ecosystem.

The final report encompassing field work from 1996 -1999 will be submitted in September, 2000. The report will include annual forage fish biomass estimates, oceanographic conditions, habitat descriptions, and will compare inter-annual variations in forage fish abundance, distributions, species composition, and length frequency.

PROFESSIONAL CONFERENCES

We anticipate presenting a poster at the 2000 EVOS Restoration Workshop, one oral presentation at the 2001 EVOS Restoration Workshop, and one oral presentation at a professional meeting.